

# Week 9 Homework

## 1 预习作业

预习教材 9.5, 9.6 节。下节课小测会考察。

## 2 编程题

Consider the following minimization problem:

$$\min f(x) = \frac{1}{2}x^T \begin{pmatrix} 1 & 0 \\ 0 & 100 \end{pmatrix} x$$

Suppose the starting point is  $x_0 = (100, 1)^T$  and we are using the negative gradient as our descent direction.

1. Suppose we use constant step size  $t$ , find the  $t$  that can achieve the optimal convergence rate. (Hint: consider the contracting coefficient.) Realize the **constant step size gradient descent**. Plot the corresponding  $x_k$  on the 2D plane and  $k - f(x_k)$  using semi-log plot (x axis is  $k$ , y axis is  $\log f(x_k)$  ).
2. Given  $\alpha = 0.4$ ,  $\beta = 0.5$ , realize the **backtracking line search**. Plot the corresponding  $x_k$  on the 2D plane and  $f(x_k)$  vs  $k$  using semi-log plot.
3. Realize **exact line search**, plot the corresponding  $x_k$  on the 2D plane and  $k - f(x_k)$  using semi-log plot.

All the algorithms stops when the 2-norm of gradient is less than  $10^{-8}$ .

## 3 作业说明

- 编程作业部分需要撰写报告，包含推导步骤和运行结果。报告提交电子版，和代码一起打包提交至网络学堂。

- 编程语言不限。
- 请大家在截止日期前提交作业，过期不候。